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COVER SHEET FOR TECHNICAL MEMORANDUM

TITLE- The "Optional Task Simulator":  
A Method for Evaluating a Hierarchical Schedule of Astronaut Tasks.

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DATE- October 20, 1967

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AUTHOR(S)- M. A. Robinson

FILING SUBJECT(S)- Scheduling  
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ABSTRACT

A method for evaluating a hierarchical schedule of astronaut tasks is described. The method consists of a computer simulation in which various levels of tasks are established, and rules for cutting across the levels are specified. A simulation run yields the probability of performing any of the tasks, the time distributions associated with those tasks that are performed, and information regarding adherence to the schedule (underruns and overruns).

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(NASA-CR-154343) THE OPTIONAL TASK  
SIMULATOR: A METHOD FOR EVALUATING  
HIERARCHICAL SCHEDULE OF ASTRONAUT TASKS  
(Bellcomm, Inc.) 27 p

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**BELLCOMM, INC.**  
1100 Seventeenth Street, N.W. Washington, D.C. 20036

**SUBJECT:** The "Optional Task Simulator":  
A Method for Evaluating a Hierarchical Schedule of Astronaut Tasks. Case 103-2

**DATE:** October 20, 1967  
**FROM:** M. A. Robinson

TECHNICAL MEMORANDUM

INTRODUCTION

In many space missions, it is desirable to maximize the accomplishment of a set of tasks during a particular mission phase. In scheduling the tasks to be accomplished, it is often useful to define a set of required tasks and a set of optional tasks, the latter to be performed by the astronaut if there is time available between the completion of the set of required tasks and the end of the mission phase. Furthermore, this "hierarchy" may have several levels, with various rules for performing tasks at different levels.

The purpose of this memorandum is to describe the "Optional Task Simulator," a computer program for evaluating a hierarchical schedule of tasks. A special feature of the simulator is that each task is allowed to take on any performance time distribution (not necessarily normal). A simulation run yields the following information:

1. The probability of performing the required tasks.
2. The probability of performing the optional tasks.
3. The time distributions associated with the required tasks.
4. The time distributions associated with the optional tasks.
5. The distribution of "overruns" (exceeding the nominal end of the schedule).
6. The distributions of time not used.

THE TASK HIERARCHY

In order to demonstrate the action of the simulator, three levels of tasks were defined as follows:

- A. Required Tasks. These tasks are regarded as essential to the success of the mission and, therefore, must be performed during the mission interval under

consideration. In the examples given in the Appendices, sufficient time was allocated to insure that the required tasks would always be performed.

- B. Optional Tasks - Experiments. These tasks are of second order of importance (as far as the simulator is concerned) and are performed if there is sufficient time left over between the completion of the required tasks and the end of the mission phase under consideration. In the examples given in the Appendices, sufficient time was allocated to perform most, but not all of the Experiments. Another feature of the Experiments is that they consist of sets of sub-tasks, which according to the ground rules we imposed, must be performed as a whole (entire task) or not at all. It should be noted at this point that the simulator is very flexible in structure and, therefore, other ground rules can be incorporated into it.
- C. Optional Tasks - Miscellaneous. These tasks, generally of short duration, are performed whenever time is available into which an Experiment, by virtue of its greater duration, cannot fit.

#### RULES FOR PERFORMING OPTIONAL TASKS

As mentioned above, sufficient time was allocated for scheduling all of the required tasks. During each "trial" (the number of trials is determined at the beginning of a simulation run), the simulator "performs" the required tasks by selecting a random performance time for each of the tasks within the limits of its performance time distribution. The time that is left over between the completion of the last of the required tasks and the end of the mission phase can be used to schedule optional tasks.

We have defined two alternate rules for scheduling an optional task:

- 1. The maximum of its performance time distribution (or the sum of the maxima of the sub-task distributions) is less than or equal to the available free time.
- 2. The mean of its performance time distribution (or the sum of the means of the sub-task distributions) is less than or equal to the available free time.

In addition, there are two alternate rules of "sequence," namely the order for examining the optional tasks for possible inclusion in the schedule of activities. These rules are as follows:

1. Strictly Sequential - taking the optional tasks in a fixed order, first to last.
2. Sequential/Temporal - taking the optional tasks in order, as above; however, if there is not enough time to perform an optional task in its correct order, the simulator will examine the successive tasks, and the first optional task that will fit into the available time will be performed.

Several combinations of rules were used for purposes of illustration. For performing the Experiments, the first example (Appendix A) made use of Rule 1A, while the second example (Appendix B) made use of Rule 2A. For performing the Miscellaneous Tasks, the first example made use of Rule 1B, while the second example made use of Rule 2B. We have designated the combination of rules used in the first example (Appendix A) as Criterion 1, and the corresponding set of rules for the second example (Appendix B) as Criterion 2.

#### RESULTS OF THE SIMULATION RUN

As was mentioned earlier, the simulator can accept any type of time distribution for the tasks, including single estimates (constants) for those tasks whose performance time distribution is not known. For purposes of illustration, we have simply assigned "rectangular" distributions to the tasks (see Table I), and these distributions are described by a mean and a spread about the mean in either direction. Thus, the first Required Task has a time distribution extending from 800 to 1600 units (seconds).

The Optional Tasks - Experiments consist of sets of sub-tasks which, as noted earlier, must be performed as a whole task or not at all. This means that in determining whether to schedule an Experiment, the simulator uses as a criterion either the sum of the means of the sub-tasks or the sum of the maxima of the sub-task distributions. However, once the simulator has decided to "perform" the Experiment, it samples from each sub-task distribution, just as it does in the case of the Required Tasks and the Optional Tasks - Miscellaneous.

The probabilities of performing the various tasks under the two criteria are given in Table II. Since we have allocated sufficient time to perform all of the Required Tasks, we see that the probability for each is 1.00. The probabilities for performing the Experiments differ under the two criteria. These probabilities must be considered in conjunction with the distributions of "time not used" (Table III), and "time overrun" (Table IV). It can be seen that in the case of Criterion 2, the probability of performing the Experiments is greater, but there is also a greater probability of overrunning the end of the mission interval. Which criterion is better is a matter of the "utility function," we are using. If we dare not overrun the schedule, clearly Criterion 1 is superior. If we are not overly concerned with overrunning the end of the schedule, but are quite concerned about making full use of the available time, Criterion 2 is superior, since there is less time not used (wasted).

The probabilities of performing the Optional Tasks - Miscellaneous cannot be interpreted in terms of the two criteria. Although the probabilities are consistently higher under Criterion 1, it must also be noted that the probabilities of performing the Optional Tasks - Experiments are lower under this criterion, thus yielding more time for performing the Miscellaneous Tasks. It should be noted that in any simulation scheme it is difficult to determine which factors are the cause of certain effects. This can only be determined by a permutation of all relevant factors along their entire range.

#### SOME CONCLUDING REMARKS

The results of this study point to the development of an "interactive" (man-computer) scheduling system for a hierarchy of tasks. Under this concept of scheduling, the person (utilizing an on-line remote console) would enter into the computer various levels of tasks with their performance time distributions, a set of rules for cutting across the levels of the task hierarchy, and an indication of the point in the distributions to be used as the time referent. The simulation program would generate the data from which an assessment of the schedule could be made, and by introducing appropriate changes, the schedule could be improved (assuming it is not optimal in the first place).

Another, and possibly more important, application of the simulator is in the analysis of the effects of various aspects of the space environment upon astronaut performance. For example, in the case of hypoxia (oxygen deprivation), there is not only a deterioration in the quality of performance, but a change in the "time domain" itself. Even simple tasks, such

as the writing of numbers, are found to require progressively longer times. It is conceivable that space environmental factors affect the nature of performance time distributions for various tasks, and that changes in the distributions are critical indicators of impending changes in the quality of performance. The simulator could be used to investigate the various parameters of recorded astronaut performance, and ultimately might be tied in to the real-time monitoring of biomedical and performance factors.

**ACKNOWLEDGMENT**

The author would like to express his appreciation to J. Cartun for assistance in the design of the simulator.



M. A. Robinson

1011-MAR-cb

Attachments  
Tables  
Appendices A & B

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TABLE I  
 PERFORMANCE TIME DISTRIBUTIONS FOR  
 THE VARIOUS TASKS AND SUB-TASKS

Type of Task	Mean	Spread
Required Tasks*		
1	1200	400
2	800	400
3	600	200
4	800	200
Optional Tasks - Experiments		
1a	400	50
b	50	20
c	150	50
2a	200	60
b	150	100
c	25	5
d	25	5
3a	300	50
b	100	10
c	50	10
Optional Tasks - Miscellaneous		
1	10	5
2	40	10
3	20	10
4	80	40
5	40	10
6	10	5

\* The sum of the means of the Required Tasks is 3400 seconds, and the maximum performance time is 4600 seconds. The length of the mission interval, for purposes of simulation, was also set at 4600 seconds, so that on the average, there would be 1200 seconds for the performance of Optional Tasks.

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TABLE II

PROBABILITY OF PERFORMING VARIOUS TASKS  
UNDER TWO DIFFERENT CRITERIA

Type of Task	Probability of Performing Tasks	
	Criterion 1*	Criterion 2**
Required Tasks		
1	1.00	1.00
2	1.00	1.00
3	1.00	1.00
4	1.00	1.00
Optional Tasks - Experiments		
1	.91	.94
2	.57	.58
3	.16	.31
Optional Tasks - Miscellaneous		
1	1.00	.92
2	1.00	.88
3	.99	.87
4	.89	.67
5	.91	.65
6	.99	.81

\* Summarized from the Facility Utilization Table, p. A-4.

\*\* Summarized from the Facility Utilization Table, p. B-4.

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TABLE III

DISTRIBUTION OF TIME NOT USED IN PERFORMING THE VARIOUS  
TASKS UNDER TWO DIFFERENT CRITERIA

Cumulative Percentage of Distributions	Criterion 1*	Criterion 2**
50%	70	70
75%	190	160
90%	360	280

\* Summarized from Table 6, p. A-8.

\*\* Summarized from Table 6, p. B-8.

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TABLE IV

DISTRIBUTION OF TIME OVERRUN IN PERFORMING THE VARIOUS  
TASKS UNDER TWO DIFFERENT CRITERIA

Cumulative Percentage of Distributions	Criterion 1*	Criterion 2**
50%	--	30
75%	--	50
90%	--	70

\* There are no overruns under Criterion 1.

\*\* Summarized from Table 7, p. B-8.

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APPENDIX A

In recent years, a number of "higher order" computer languages have been developed to facilitate the implementation of simulation schemes such as the one described here. These languages enable the user to write a simulation program in terms of a special repertory of operations, which the computer translates into its own (machine) language.

The simulation language that most closely corresponded to our requirements was judged to be the IBM General Purpose Systems Simulator, Version II (GPSS II). A description of the language, and some examples of its application, can be found elsewhere (References 1, 2 and 3). A later version of this language is also available (GPSS III), which extends the repertory of operations further, and descriptions of this version are also available (References 4 and 5).

The simulation program for "performing" the tasks under Criterion 1 is listed on pages A-2 to A-4 (up to the START statement), and the rest of the listing, to A-8 inclusive, consists of the output. Since the tables are not automatically labeled by the computer, the author added titles in parentheses.

## THE GENERAL PURPOSE SYSTEMS SIMULATOR MARK II

IBM VERSION 2 LEVEL 1 05/22/64

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LOC	NAME	X	Y	Z	SEL	NBA	NBB	MEAN	MOD	REMARKS
JOB		OPTIONAL TASK SIMULATOR-EXPERIMENT SEQ *MAX*								

\*  
\*  
\*REQUIRED TASK LINE- FACILITY '5'

10	ORIGINATE		1		20		1			
20	ASSIGN	P8		K100		30				
30	MARK					32				
32	SEIZE		5			40				
40	HOLD		40			50		1200	400	
50	HOLD		50			60		800	400	
60	HOLD		60			70		600	200	
70	HOLD		70			72		800	200	
72	RELEASE		5			76				
76	TABULATE		1			80				
80	SAVEX		1	M1		90				
90	MARK					100				

\*  
\*  
\*  
\*  
\*OPTIONAL EXPERIMENT BANK

100	ASSIGN	P1	K1		102					
102	ADVANCE			BOTH	104	500				
104	COMPARE	FN2	LE	V1		108				

\*  
\*EXP-1 FACILITY '1'

108	SEIZE		1		110					
110	HOLD		11		120		400	50		
120	HOLD		12		130		50	20		
130	HOLD		13		140		150	50		
140	RELEASE		1		145					
145	TABULATE		2		150					
150	SAVEX		2	M1	160					
160	MARK				200					

200	ASSIGN	P1	K2		202					
202	ADVANCE			BOTH	204	500				
204	COMPARE	FN2	LE	V1		208				

\*  
\*EXP-2 FACILITY '2'

208	SEIZE		2		210					
210	HOLD		21		220		200	60		
220	HOLD		22		230		150	100		
230	HOLD		23		240		25	5		
240	HOLD		24		250		25	5		
250	RELEASE		2		255					
255	TABULATE		3		260					
260	SAVEX		3	M1	270					
270	MARK				300					

300	ASSIGN	P1	R3		302					
-----	--------	----	----	--	-----	--	--	--	--	--

302	ADVANCE			BOTH	304	500				
304	COMPARE	FN2	LE	V1		308				

\*  
\*EXP-3 FACILITY '3'

308	SEIZE		3		310					
310	HOLD		31		320		300	50		
320	HOLD		32		330		100	10		
330	HOLD		33		340		50	10		
340	RELEASE		3		345					
345	TABULATE		4		350					
350	SAVEX		4	M1	352					
352	MARK				500					

LOC	NAME	X	Y	Z	SEL	NBA	NBB	MEAN	MOD	REMARKS
-----	------	---	---	---	-----	-----	-----	------	-----	---------

## \* OPTIONAL TASK LINE

500	ASSIGN	P1	K1			502				
502	ASSIGN	P4	V1			510				
510	ASSIGN	P2	K525			515				
515	ADVANCE			BOTH	520	535				
520	COMPARE	FN4	LE	V1		*2				
525	HOLD	81			535		10	5		
526	HOLD	82			535		40	10		
527	HOLD	83			535		20	10		
528	HOLD	84			535		80	40		
529	HOLD	85			535		40	10		
530	HOLD	86			540		10	5		
535	ASSIGN	P2	V2	BOTH	537	540				
537	COMPARE	P2	LE	K530		539				
539	ASSIGN	P1	V3			515				
540	ASSIGN	P5	V4			551				
541	TABULATE	6			542					
542	SAVEX	X1	K0			543				
543	SAVEX	X2	K0			544				
544	SAVEX	X3	K0			545				
545	SAVEX	X4	K0			590				
551	ADVANCE			BOTH	553	566				
553	COMPARE	P5	GE	K600		555				
555	ASSIGN	P5	V1			561				
561	MARK	P7				564				
564	ADVANCE				541	*5				
566	ASSIGN	P5	V5			568				
568	MARK	P7				570				
570	ADVANCE					572	*5			
572	TABULATE	7				542				
590	ADVANCE			BOTH	592	650				
592	COMPARE	P4	GE	K0		603				

## \* TIME LEFT FOR OPTIONAL TASKS

603	MARK	P7			604					
604	ADVANCE					605	*4			
605	TABULATE	5				650				
650	LOOP	8				30	699			
699	TERMINATE	R								

## \* VARIABLE TABLE

## \* PARAMETERS

*1	USED FOR FUNCTION LOOKUP									
*2	TASK LOCATER									
*3	NOT USED									
*4	USED FOR TIME LEFT FOR OPT. TASK TABLE									
*5	TIME NOT USED AND TIME OVERRUN TABLES									
*6	NOT USED									
*7	TABLES 5,6,7									
*8	NUMBER OF TRANSACTIONS									

1	VARIABLE	K4600-MI-X1-X2-X3-X4				FREE TIME FOR OPT. TASKS				
2	VARIABLE	P2+K1				TASK LOCATER				
3	VARIABLE	P1+K1				FUNCTION TIME				
4	VARIABLE	K5200-M1-X1-X2-X3-X4				TABLE VARIABLE FOR TIME				
5	VARIABLE	K600-V4				TIME OVERRUN				

## \* FUNCTION FOR EXPERIMENT TIME-MEAN

1	FUNCTION	P1	3							
1	600	2	400	3	450					

## \* FUNCTION FOR EXPERIMENT TIME-MAX

2	FUNCTION	P1	3							
1	720	2	570	3	520					

## \*FUNCTION FOR OPTIONAL TASKS-MEAN

3	FUNCTION	P1	6								
1	10	2	40	3	20	4	80	5	40	6	10

## \*FUNCTION FOR OPTIONAL TASKS MAX

4	FUNCTION	P1	6								
1	15	2	50	3	30	4	120	5	50	6	15

## \*TABLES FOR STATISTICAL PRINTOUTS

1	TABLE	M1	2000	100	30	REQUIRED ACTION TIME					
2	TABLE	M1	480	10	24	EXP-1 ACTION TIME					
3	TABLE	M1	280	10	40	EXP-2 ACTION TIME					
4	TABLE	M1	280	10	30	EXP-3 ACTION TIME					
5	TABLE	MP7	0	20	50	TIME LEFT FOR OPT TASKS					
6	TABLE	MP7	0	10	70	TIME NOT USED					
7	TABLE	MP7	0	10	25	TIME OVERRUN					

\* START

CLOCK TIME REL 497312 ABS 497312

TRANS COUNTS	BLOCK TRANS,TOTAL						
10	0, 1	20	0, 1	30	0, 100	32	0, 100
50	0, 100	60	0, 100	70	0, 100	72	0, 100
80	0, 100	90	0, 100	100	0, 100	102	0, 100
108	0, 91	110	0, 91	120	0, 91	130	0, 91
145	0, 91	150	0, 91	160	0, 91	200	0, 91
204	0, 57	208	0, 57	210	0, 57	220	0, 57
240	0, 57	250	0, 57	255	0, 57	260	0, 57
300	0, 57	302	0, 57	304	0, 16	308	0, 16
320	0, 16	330	0, 16	340	0, 16	345	0, 16
352	0, 16	500	0, 100	502	0, 100	510	0, 100
520	0, 578	525	0, 100	526	0, 100	527	0, 99
529	0, 91	530	0, 99	535	0, 501	537	0, 500
540	0, 100	541	0, 100	542	0, 100	543	0, 100
545	0, 100	551	0, 100	553	0, 100	555	0, 100
564	0, 100	566	0, 0	568	0, 0	570	0, 0
590	0, 100	592	0, 100	603	0, 100	604	0, 100
650	0, 100	699	0, 1				

## (AVERAGE UTILIZATION OF FACILITIES)

FACILITY NR	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRANS	TRANS	\$TRANS
1	.1099	91	600.43	0	0
2	.0447	57	389.84	0	0
3	.0144	16	448.50	0	0
5	.6810	100	3386.53	0	0
11	.0738	91	403.24	0	0
12	.0091	91	49.82	0	0
13	.0270	91	147.36	0	0
21	.0225	57	195.91	0	0
22	.0164	57	143.42	0	0
23	.0029	57	25.21	0	0
24	.0029	57	25.30	0	0
31	.0097	16	300.31	0	0
32	.0032	16	98.06	0	0
33	.0016	16	50.13	0	0
40	.2339	100	1163.21	0	0
50	.1672	100	831.34	0	0
60	.1188	100	590.84	0	0
70	.1611	100	801.14	0	0
81	.0021	100	10.22	0	0
82	.0081	100	40.15	0	0
83	.0040	99	20.01	0	0
84	.0140	89	78.19	0	0
85	.0074	91	40.34	0	0
86	.0020	99	10.11	0	0

TABLE NUMBER 1 (ACTION TIME FOR REQUIRED TASKS)

ENTRIES IN TABLE		MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED	
100		3386.530	347.942		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN
2000	0	.00	.0	100.0	.591
2100	0	.00	.0	100.0	.620
2200	0	.00	.0	100.0	.650
2300	0	.00	.0	100.0	.679
2400	0	.00	.0	100.0	.709
2500	0	.00	.0	100.0	.738
2600	0	.00	.0	100.0	.768
2700	1	1.00	1.0	99.0	.797
2800	2	2.00	3.0	97.0	.827
2900	3	3.00	6.0	94.0	.856
3000	5	5.00	11.0	89.0	.886
3100	11	11.00	22.0	78.0	.915
3200	14	14.00	36.0	64.0	.945
3300	11	11.00	47.0	53.0	.974
3400	9	9.00	56.0	44.0	1.004
3500	6	6.00	62.0	38.0	1.034
3600	9	9.00	71.0	29.0	1.063
3700	9	9.00	80.0	20.0	1.093
3800	6	6.00	86.0	14.0	1.122
3900	5	5.00	91.0	9.0	1.152
4000	4	4.00	95.0	5.0	1.181
4100	2	2.00	97.0	3.0	1.211
4200	3	3.00	100.0	0.0	1.240

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 2 (ACTION TIME FOR EXPERIMENT 1)

ENTRIES IN TABLE		MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED	
91		600.429	43.957		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN
480	0	.00	.0	100.0	.799
490	0	.00	.0	100.0	.816
500	0	.00	.0	100.0	.833
510	0	.00	.0	100.0	.849
520	2	2.20	2.2	97.8	.866
530	2	2.20	4.4	95.6	.883
540	6	6.59	11.0	89.0	.899
550	4	4.40	15.4	84.6	.916
560	4	4.40	19.8	80.2	.933
570	9	9.89	29.7	70.3	.949
580	4	4.40	34.1	65.9	.966
590	6	6.59	40.7	59.3	.983
600	9	9.89	50.5	49.5	.999
610	5	5.49	56.0	44.0	1.016
620	9	9.89	65.9	34.1	1.033
630	7	7.69	73.6	26.4	1.049
640	6	6.59	80.2	19.8	1.066
650	6	6.59	86.8	13.2	1.083
660	1	1.10	87.9	12.1	1.099
670	6	6.59	94.5	5.5	1.116
680	2	2.20	96.7	3.3	1.133
690	2	2.20	98.9	1.1	1.149
700	1	1.10	100.0	0.0	1.166

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 3 (ACTION TIME FOR EXPERIMENT 2)

ENTRIES IN TABLE  
57MEAN ARGUMENT  
389.842STANDARD DEVIATION  
66.609

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
280	4	7.02	7.0	93.0	.718	-1.649
290	1	1.75	8.8	91.2	.744	-1.499
300	0	.00	8.8	91.2	.770	-1.349
310	3	5.26	14.0	86.0	.795	-1.199
320	3	5.26	19.3	80.7	.821	-1.049
330	2	3.51	22.8	77.2	.846	-.898
340	0	.00	22.8	77.2	.872	-.748
350	3	5.26	28.1	71.9	.898	-.598
360	2	3.51	31.6	68.4	.923	-.448
370	2	3.51	35.1	64.9	.949	-.298
380	7	12.28	47.4	52.6	.975	-.148
390	1	1.75	49.1	50.9	1.000	.002
400	4	7.02	56.1	43.9	1.026	.153
410	2	3.51	59.6	40.4	1.052	.303
420	3	5.26	64.9	35.1	1.077	.453
430	2	3.51	68.4	31.6	1.103	.603
440	5	8.77	77.2	22.8	1.129	.753
450	2	3.51	80.7	19.3	1.154	.903
460	3	5.26	86.0	14.0	1.180	1.053
470	1	1.75	87.7	12.3	1.206	1.203
480	2	3.51	91.2	8.8	1.231	1.354
490	2	3.51	94.7	5.3	1.257	1.504
500	1	1.75	96.5	3.5	1.283	1.654
510	0	.00	96.5	3.5	1.308	1.804
520	0	.00	96.5	3.5	1.334	1.954
530	1	1.75	98.2	1.8	1.360	2.104
540	1	1.75	100.0	.0	1.385	2.254

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 4 (ACTION TIME FOR EXPERIMENT 3)

ENTRIES IN TABLE  
16MEAN ARGUMENT  
448.500STANDARD DEVIATION  
31.452

NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
280	0	.00	.0	100.0	.624	-5.357
290	0	.00	.0	100.0	.647	-5.039
300	0	.00	.0	100.0	.669	-4.721
310	0	.00	.0	100.0	.691	-4.403
320	0	.00	.0	100.0	.713	-4.086
330	0	.00	.0	100.0	.736	-3.768
340	0	.00	.0	100.0	.758	-3.450
350	0	.00	.0	100.0	.780	-3.132
360	0	.00	.0	100.0	.803	-2.814
370	0	.00	.0	100.0	.825	-2.496
380	0	.00	.0	100.0	.847	-2.178
390	0	.00	.0	100.0	.870	-1.860
400	1	6.25	6.3	93.8	.892	-1.542
410	1	6.25	12.5	87.5	.914	-1.224
420	2	12.50	25.0	75.0	.936	-.906
430	1	6.25	31.3	68.8	.959	-.588
440	3	18.75	50.0	50.0	.981	-.270
450	1	6.25	56.3	43.8	1.003	.048
460	0	.00	56.3	43.8	1.026	.366
470	3	18.75	75.0	25.0	1.048	.684
480	1	6.25	81.3	18.8	1.070	1.002
490	1	6.25	87.5	12.5	1.093	1.319
500	1	6.25	93.8	6.3	1.115	1.637
510	1	6.25	100.0	.0	1.137	1.955

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 5 (TIME LEFT FOR OPTIONAL TASKS)

ENTRIES IN TABLE		MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED	
100		373.110	139.633		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMINDER	MULTIPLE OF MEAN
0	0	.00	.0	100.0	.000
20	0	.00	.0	100.0	.054
40	0	.00	.0	100.0	.107
60	0	.00	.0	100.0	.161
80	1	1.00	1.0	99.0	.214
100	1	1.00	2.0	98.0	.268
120	3	3.00	5.0	95.0	.322
140	3	3.00	8.0	92.0	.375
160	2	2.00	10.0	90.0	.429
180	1	1.00	11.0	89.0	.482
200	0	.00	11.0	89.0	.536
220	5	5.00	16.0	84.0	.590
240	4	4.00	20.0	80.0	.643
260	4	4.00	24.0	76.0	.697
280	1	1.00	25.0	75.0	.750
300	4	4.00	29.0	71.0	.804
320	4	4.00	33.0	67.0	.858
340	6	6.00	39.0	61.0	.911
360	4	4.00	43.0	57.0	.965
380	6	6.00	49.0	51.0	1.018
400	4	4.00	53.0	47.0	1.072
420	5	5.00	58.0	42.0	1.126
440	6	6.00	64.0	36.0	1.179
460	9	9.00	73.0	27.0	1.233
480	5	5.00	78.0	22.0	1.286
500	5	5.00	83.0	17.0	1.340
520	5	5.00	88.0	12.0	1.394
540	2	2.00	90.0	10.0	1.447
560	3	3.00	93.0	7.0	1.501
580	2	2.00	95.0	5.0	1.555
600	1	1.00	96.0	4.0	1.608
620	1	1.00	97.0	3.0	1.662
640	0	.00	97.0	3.0	1.715
660	1	1.00	98.0	2.0	1.769
680	0	.00	98.0	2.0	1.823
700	2	2.00	100.0	0	1.876

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 6 (TIME NOT USED)

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED			
100	186.620	120.705				
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	.000	-1.546
10	1	1.00	1.0	99.0	.054	-1.463
20	4	4.00	5.0	95.0	.107	-1.380
30	6	6.00	11.0	89.0	.161	-1.298
40	6	6.00	17.0	83.0	.214	-1.215
50	3	3.00	20.0	80.0	.268	-1.132
60	2	2.00	22.0	78.0	.322	-1.049
70	4	4.00	26.0	74.0	.375	-.966
80	1	1.00	27.0	73.0	.429	-.883
90	1	1.00	28.0	72.0	.482	-.800
100	4	4.00	32.0	68.0	.536	-.718
110	0	.00	32.0	68.0	.589	-.635
120	1	1.00	33.0	67.0	.643	-.552
130	4	4.00	37.0	63.0	.697	-.469
140	2	2.00	39.0	61.0	.750	-.386
150	4	4.00	43.0	57.0	.804	-.303
160	0	.00	43.0	57.0	.857	-.221
170	1	1.00	44.0	56.0	.911	-.138
180	3	3.00	47.0	53.0	.965	-.055
190	3	3.00	50.0	50.0	1.018	.028
200	4	4.00	54.0	46.0	1.072	.111
210	3	3.00	57.0	43.0	1.125	.194
220	3	3.00	60.0	40.0	1.179	.277
230	3	3.00	63.0	37.0	1.232	.359
240	3	3.00	66.0	34.0	1.286	.442
250	1	1.00	67.0	33.0	1.340	.525
260	1	1.00	68.0	32.0	1.393	.608
270	2	2.00	70.0	30.0	1.447	.691
280	6	6.00	76.0	24.0	1.500	.774
290	4	4.00	80.0	20.0	1.554	.856
300	1	1.00	81.0	19.0	1.608	.939
310	3	3.00	84.0	16.0	1.661	1.022
320	2	2.00	86.0	14.0	1.715	1.105
330	1	1.00	87.0	13.0	1.768	1.188
340	2	2.00	89.0	11.0	1.822	1.271
350	0	.00	89.0	11.0	1.875	1.354
360	2	2.00	91.0	9.0	1.929	1.436
370	0	.00	91.0	9.0	1.983	1.519
380	2	2.00	93.0	7.0	2.036	1.602
390	3	3.00	96.0	4.0	2.090	1.685
400	0	.00	96.0	4.0	2.143	1.768
410	2	2.00	98.0	2.0	2.197	1.851
420	0	.00	98.0	2.0	2.251	1.933
430	0	.00	98.0	2.0	2.304	2.016
440	0	.00	98.0	2.0	2.358	2.099
450	0	.00	98.0	2.0	2.411	2.182
460	1	1.00	99.0	1.0	2.465	2.265
470	0	.00	99.0	1.0	2.518	2.348
480	1	1.00	100.0	.0	2.572	2.431

**BELLCOMM, INC.**

APPENDIX B

The simulation program for "performing" the tasks under Criterion 2 is listed on pages B-2 to B-4 (up to the START statement). The balance of the listing, to A-8 inclusive, constitutes the output of the simulation run.

It should be noted that while this listing contains a table of "Time Overrun," (Table 7, p. B-8), the listing in Appendix A does not. This is because there were no overruns in the previous example, and the computer does not ordinarily print out a "null" table.

## THE GENERAL PURPOSE SYSTEMS SIMULATOR MARK II

IBM VERSION 2 LEVEL 1 05/22/64

BELLCOMM, INC.

WASHINGTON, D.C.

LOC NAME X Y Z SEL NBA NBB MEAN MOD REMARKS  
 JOB OPTIONAL TASK SIMULATOR-EXPERIMENT SEQ 'MEAN'

\*REQUIRED TASK LINE- FACILITY '5'

10	ORIGINATE	1	20	1
20	ASSIGN	P8	K100	30
30	MARK			32
32	SEIZE	5	40	
40	HOLD	40	50	1200 400
50	HOLD	50	60	800 400
60	HOLD	60	70	600 200
70	HOLD	70	72	800 200
72	RELEASE	5	76	
76	TABULATE	1	80	
80	SAVEX	1	M1	90
90	MARK			100

**\*OPTIONAL EXPERIMENT BANK**

100	ASSIGN	P1	K1		102	
102	ADVANCE			BOTH	104	500
104	COMPARE	FN1	LE	V1		108

\*EXP-1 FACILITY '1'

108	SEIZE	1		110		
110	HOLD	11		120	400	50
120	HOLD	12		130	50	20
130	HOLD	13		140	150	50
140	RELEASE	1		145		
145	TABULATE	2		150		
150	SAVEX	2	M1	160		
160	MARK			200		

200	ASSIGN	P1	K2		202	
202	ADVANCE			BOTH	204	500
204	COMPARE	FN1	LE	VI	208	

\*EXP-2 FACILITY '2

208	SEIZE	2	210		
210	HOLD	21	220	200	60
220	HOLD	22	230	150	100
230	HOLD	23	240	25	5
240	HOLD	24	250	25	5
250	RELEASE	2	255		
255	TABULATE	3	260		
260	SAVEX	3	M1	270	
270	MARK			300	

300 ASSIGN P1 K3 302

302	ADVANCE				BOTH	304	500
304	COMPARE	FN1	LE	V1		308	

\*EXP-3 FACILITY '3\*

308	SEIZE	3		310		
310	HOLD	31		320	300	50
320	HOLD	32		330	100	10
330	HOLD	33		340	50	10
340	RELEASE	3		345		
345	TABULATE	4		350		
350	SAVEX	4	M1	352		
352	MARK			500		

LOC	NAME	X	Y	Z	SEL	NBA	NBB	MEAN	MOD	REMARKS
• *OPTIONAL TASK LINE										
500	ASSIGN	P1	K1			502				
502	ASSIGN	P4	V1			510				
510	ASSIGN	P2	K525			515				
515	ADVANCE			BOTH	520	535				
520	COMPARE	FN3	LE	V1		*2				
525	HOLD	81				535		10	5	
526	HOLD	82				535		40	10	
527	HOLD	83				535		20	10	
528	HOLD	84				535		80	40	
529	HOLD	85				535		40	10	
530	HOLD	86				540		10	5	
535	ASSIGN	P2	V2	BOTH	537	540				
537	COMPARE	P2	LE	K530		539				
539	ASSIGN	P1	V3			515				
540	ASSIGN	P5	V4			551				
541	TABULATE	6				542				
542	SAVEX	X1	K0			543				
543	SAVEX	X2	K0			544				
544	SAVEX	X3	K0			545				
545	SAVEX	X4	K0			590				
551	ADVANCE			BOTH	553	566				
553	COMPARE	P5	GE	K600		555				
555	ASSIGN	P5	V1			561				
561	MARK	P7				564				
564	ADVANCE					541		*5		
566	ASSIGN	P5	V5			568				
568	MARK	P7				570				
570	ADVANCE					572		*5		
572	TABULATE	7				542				
590	ADVANCE			BOTH	592	650				
592	COMPARE	P4	GE	K0		603				
• TIME LEFT FOR OPTIONAL TASKS										
603	MARK	P7				604				
604	ADVANCE					605		*4		
605	TABULATE	5				650				
650	LOOP	8				30	699			
699	TERMINATE	R								
• *VARIABLE TABLE										
• *PARAMETERS										
*1	USED FOR FUNCTION LOOKUP									
*2	TASK LOCATER									
*3	NOT USED									
*4	USED FOR TIME LEFT FOR OPT. TASK TABLE									
*5	TIME NOT USED AND TIME OVERRUN TABLES									
*6	NOT USED									
*7	TABLES 5,6,7									
*8	NUMBER OF TRANSACTIONS									
1	VARIABLE	K4600-M1-X1-X2-X3-X4				FREE TIME FOR OPT. TASKS				
2	VARIABLE	P2+K1				TASK LOCATER				
3	VARIABLE	P1+K1				FUNCTION TIME				
4	VARIABLE	K5200-M1-X1-X2-X3-X4				TABLE VARIABLE FOR TIME				
5	VARIABLE	K600-V4				TIME OVERRUN				

## \*FUNCTION FOR EXPERIMENT TIME-MEAN

1	FUNCTION	P1	3
1	600	2	400
1		3	450

## \*FUNCTION FOR EXPERIMENT TIME-MAX

2	FUNCTION	P1	3
1	720	2	570
1		3	520

## \*FUNCTION FOR OPTIONAL TASKS-MEAN

3	FUNCTION	P1	6
1	10	2	40
1	3	20	4
1		80	5
1		40	6
1		10	

## \*FUNCTION FOR OPTIONAL TASKS MAX

4	FUNCTION	P1	6
1	15	2	50
1	3	30	4
1		120	5
1		50	6
1		15	

## \*TABLES FOR STATISTICAL PRINTOUTS

1	TABLE	M1	2000	100	30	REQUIRED ACTION TIME
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LOC	NAME	X	Y	Z	SEL	NBA	NBB	MEAN	MOD	REMARKS
2	TABLE	M1	480	10	24					EXP-1 ACTION TIME
3	TABLE	M1	280	10	40					EXP-2 ACTION TIME
4	TABLE	M1	280	10	30					EXP-3 ACTION TIME
5	TABLE	MP7	0	20	50					TIME LEFT FOR OPT TASKS
6	TABLE	MP7	0	10	70					TIME NOT USED
7	TABLE	MP7	0	10	25					TIME OVERRUN

START

CLOCK TIME	REL	484081	ABS	484081						
TRANS COUNTS		BLOCK TRANS,TOTAL								
	10	0, 1	20	0, 1	30	0, 100	32	0, 100	40	0, 100
	50	0, 100	60	0, 100	70	0, 100	72	0, 100	76	0, 100
	80	0, 100	90	0, 100	100	0, 100	102	0, 100	104	0, 94
	108	0, 94	110	0, 94	120	0, 94	130	0, 94	140	0, 94
	145	0, 94	150	0, 94	160	0, 94	200	0, 94	202	0, 94
	204	0, 68	208	0, 68	210	0, 68	220	0, 68	230	0, 68
	240	0, 68	250	0, 68	255	0, 68	260	0, 68	270	0, 68
	300	0, 68	302	0, 68	304	0, 31	308	0, 31	310	0, 31
	320	0, 31	330	0, 31	340	0, 31	345	0, 31	350	0, 31
	352	0, 31	500	0, 100	502	0, 100	510	0, 100	515	0, 600
	520	0, 480	525	0, 92	526	0, 88	527	0, 87	528	0, 67
	529	0, 65	530	0, 81	535	0, 519	537	0, 500	539	0, 500
	540	0, 100	541	0, 87	542	0, 100	543	0, 100	544	0, 100
	545	0, 100	551	0, 100	553	0, 87	555	0, 87	561	0, 87
	564	0, 87	566	0, 13	568	0, 13	570	0, 13	572	0, 13
	590	0, 100	592	0, 100	603	0, 100	604	0, 100	605	0, 100
	650	0, 100	699	0, 1						

FACILITY NR	AVERAGE UTILIZATION	NUMBER ENTRIES	AVERAGE TIME/TRANS	TRANS	\$TRANS
1	.1168	94	601.55	0	0
2	.0557	68	396.54	0	0
3	.0282	31	439.71	0	0
5	.7023	100	3399.55	0	0
11	.0780	94	401.78	0	0
12	.0097	94	49.98	0	0
13	.0291	94	149.80	0	0
21	.0284	68	202.44	0	0
22	.0201	68	142.90	0	0
23	.0036	68	25.46	0	0
24	.0036	68	25.75	0	0
31	.0186	31	290.55	0	0
32	.0064	31	100.06	0	0
33	.0031	31	49.10	0	0
40	.2495	100	1207.73	0	0
50	.1644	100	795.70	0	0
60	.1232	100	596.32	0	0
70	.1652	100	799.80	0	0
81	.0019	92	9.93	0	0
82	.0071	88	38.83	0	0
83	.0035	87	19.24	0	0
84	.0111	67	80.16	0	0
85	.0054	65	40.45	0	0
86	.0017	81	10.25	0	0

TABLE NUMBER 1

(ACTION TIME FOR REQUIRED TASKS)

ENTRIES IN TABLE		MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED		
100		3399.550	387.530			
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
2000	0	.00	.0	100.0	.588	-3.611
2100	0	.00	.0	100.0	.618	-3.353
2200	0	.00	.0	100.0	.647	-3.095
2300	0	.00	.0	100.0	.677	-2.837
2400	0	.00	.0	100.0	.706	-2.579
2500	0	.00	.0	100.0	.735	-2.321
2600	0	.00	.0	100.0	.765	-2.063
2700	3	3.00	3.0	97.0	.794	-1.805
2800	2	2.00	5.0	95.0	.824	-1.547
2900	4	4.00	9.0	91.0	.853	-1.289
3000	4	4.00	13.0	87.0	.882	-1.031
3100	9	9.00	22.0	78.0	.912	-.773
3200	16	16.00	38.0	62.0	.941	-.515
3300	11	11.00	49.0	51.0	.971	-.257
3400	7	7.00	56.0	44.0	1.000	.001
3500	6	6.00	62.0	38.0	1.030	.259
3600	5	5.00	67.0	33.0	1.059	.517
3700	3	3.00	70.0	30.0	1.088	.775
3800	9	9.00	79.0	21.0	1.118	1.033
3900	7	7.00	86.0	14.0	1.147	1.291
4000	8	8.00	94.0	6.0	1.177	1.549
4100	3	3.00	97.0	3.0	1.206	1.807
4200	3	3.00	100.0	.0	1.235	2.066

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 2

(ACTION TIME FOR EXPERIMENT 1)

ENTRIES IN TABLE		MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED		
94		601.553	45.760			
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
480	0	.00	.0	100.0	.798	-2.656
490	0	.00	.0	100.0	.815	-2.438
500	0	.00	.0	100.0	.831	-2.219
510	1	1.06	1.1	98.9	.848	-2.001
520	1	1.06	2.1	97.9	.864	-1.782
530	4	4.26	6.4	93.6	.881	-1.564
540	6	6.38	12.8	87.2	.898	-1.345
550	2	2.13	14.9	85.1	.914	-1.127
560	7	7.45	22.3	77.7	.931	-.908
570	6	6.38	28.7	71.3	.948	-.690
580	4	4.26	33.0	67.0	.964	-.471
590	6	6.38	39.4	60.6	.981	-.252
600	6	6.38	45.7	54.3	.997	-.034
610	10	10.64	56.4	43.6	1.014	.185
620	8	8.51	64.9	35.1	1.031	.403
630	8	8.51	73.4	26.6	1.047	.622
640	6	6.38	79.8	20.2	1.064	.840
650	3	3.19	83.0	17.0	1.081	1.059
660	5	5.32	88.3	11.7	1.097	1.277
670	3	3.19	91.5	8.5	1.114	1.496
680	3	3.19	94.7	5.3	1.130	1.714
690	4	4.26	98.9	1.1	1.147	1.933
700	1	1.06	100.0	.0	1.164	2.151

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 3 (ACTION TIME FOR EXPERIMENT 2)

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED
68	396.544	65.077	
280	2	2.94	2.9
290	1	1.47	4.4
300	1	1.47	5.9
310	1	1.47	7.4
320	3	4.41	11.8
330	3	4.41	16.2
340	2	2.94	19.1
350	6	8.82	27.9
360	0	.00	27.9
370	5	7.35	35.3
380	4	5.88	41.2
390	3	4.41	45.6
400	9	13.24	58.8
410	4	5.88	64.7
420	4	5.88	70.6
430	1	1.47	72.1
440	0	.00	72.1
450	4	5.88	77.9
460	2	2.94	80.9
470	3	4.41	85.3
480	1	1.47	86.8
490	1	1.47	88.2
500	3	4.41	92.6
510	1	1.47	94.1
520	1	1.47	95.6
530	2	2.94	98.5
540	1	1.47	100.0

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 4 (ACTION TIME FOR EXPERIMENT 3)

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION	NON-WEIGHTED
31	439.710	27.832	
280	0	.00	.0
290	0	.00	.0
300	0	.00	.0
310	0	.00	.0
320	0	.00	.0
330	0	.00	.0
340	0	.00	.0
350	0	.00	.0
360	0	.00	.0
370	0	.00	.0
380	0	.00	.0
390	0	.00	.0
400	1	3.23	3.2
410	5	16.13	19.4
420	3	9.68	29.0
430	2	6.45	35.5
440	6	19.35	54.8
450	3	9.68	64.5
460	5	16.13	80.6
470	2	6.45	87.1
480	2	6.45	93.5
490	0	.00	93.5
500	1	3.23	96.8
510	1	3.23	100.0

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 5 (TIME LEFT FOR OPTIONAL TASKS)

ENTRIES IN TABLE		MEAN ARGUMENT		STANDARD DEVIATION		
100		232.420		154.914		NON-WEIGHTED
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	7	7.00	7.0	93.0	.000	-1.500
20	2	2.00	9.0	91.0	.086	-1.371
40	2	2.00	11.0	89.0	.172	-1.242
60	4	4.00	15.0	85.0	.258	-1.113
80	3	3.00	18.0	82.0	.344	-.984
100	8	8.00	26.0	74.0	.430	-.855
120	3	3.00	29.0	71.0	.516	-.726
140	3	3.00	32.0	68.0	.602	-.597
160	3	3.00	35.0	65.0	.688	-.467
180	8	8.00	43.0	57.0	.774	-.338
200	2	2.00	45.0	55.0	.861	-.209
220	1	1.00	46.0	54.0	.947	-.080
240	8	8.00	54.0	46.0	1.033	.049
260	4	4.00	58.0	42.0	1.119	.178
280	3	3.00	61.0	39.0	1.205	.307
300	8	8.00	69.0	31.0	1.291	.436
320	3	3.00	72.0	28.0	1.377	.565
340	6	6.00	78.0	22.0	1.463	.694
360	3	3.00	81.0	19.0	1.549	.824
380	0	.00	81.0	19.0	1.635	.953
400	2	2.00	83.0	17.0	1.721	1.082
420	1	1.00	84.0	16.0	1.807	1.211
440	5	5.00	89.0	11.0	1.893	1.340
460	2	2.00	91.0	9.0	1.979	1.469
480	4	4.00	95.0	5.0	2.065	1.598
500	1	1.00	96.0	4.0	2.151	1.727
520	0	.00	96.0	4.0	2.237	1.856
540	1	1.00	97.0	3.0	2.323	1.985
560	1	1.00	98.0	2.0	2.409	2.115
580	1	1.00	99.0	1.0	2.495	2.244
600	0	.00	99.0	1.0	2.582	2.373
620	0	.00	99.0	1.0	2.668	2.502
640	0	.00	99.0	1.0	2.754	2.631
660	0	.00	99.0	1.0	2.840	2.760
680	0	.00	99.0	1.0	2.926	2.889
700	0	.00	99.0	1.0	3.012	3.018
720	1	1.00	100.0	.0	3.098	3.147

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 6 (TIME NOT USED)

ENTRIES IN TABLE 87		MEAN ARGUMENT 97.552	STANDARD DEVIATION 109.952	NON-WEIGHTED		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	3	3.45	3.4	96.6	.000	-.887
10	18	20.69	24.1	75.9	.103	-.796
20	7	8.05	32.2	67.8	.205	-.705
30	6	6.90	39.1	60.9	.308	-.614
40	5	5.75	44.8	55.2	.410	-.523
50	3	3.45	48.3	51.7	.513	-.432
60	1	1.15	49.4	50.6	.615	-.342
70	5	5.75	55.2	44.8	.718	-.251
80	5	5.75	60.9	39.1	.820	-.160
90	3	3.45	64.4	35.6	.923	-.069
100	2	2.30	66.7	33.3	1.025	.022
110	2	2.30	69.0	31.0	1.128	.113
120	2	2.30	71.3	28.7	1.230	.204
130	0	.00	71.3	28.7	1.333	.295
140	1	1.15	72.4	27.6	1.435	.386
150	1	1.15	73.6	26.4	1.538	.477
160	2	2.30	75.9	24.1	1.640	.568
170	0	.00	75.9	24.1	1.743	.659
180	2	2.30	78.2	21.8	1.845	.750
190	1	1.15	79.3	20.7	1.948	.841
200	1	1.15	80.5	19.5	2.050	.932
210	3	3.45	83.9	16.1	2.153	1.023
220	1	1.15	85.1	14.9	2.255	1.114
230	2	2.30	87.4	12.6	2.358	1.205
240	0	.00	87.4	12.6	2.460	1.296
250	0	.00	87.4	12.6	2.563	1.386
260	0	.00	87.4	12.6	2.665	1.477
270	1	1.15	88.5	11.5	2.768	1.568
280	3	3.45	92.0	8.0	2.870	1.659
290	1	1.15	93.1	6.9	2.973	1.750
300	1	1.15	94.3	5.7	3.075	1.841
310	1	1.15	95.4	4.6	3.178	1.932
320	0	.00	95.4	4.6	3.280	2.023
330	0	.00	95.4	4.6	3.383	2.114
340	1	1.15	96.6	3.4	3.485	2.205
350	1	1.15	97.7	2.3	3.588	2.296
360	0	.00	97.7	2.3	3.690	2.387
370	0	.00	97.7	2.3	3.793	2.478
380	1	1.15	98.9	1.1	3.895	2.569
390	0	.00	98.9	1.1	3.998	2.660
400	0	.00	98.9	1.1	4.100	2.751
410	0	.00	98.9	1.1	4.203	2.842
420	0	.00	98.9	1.1	4.305	2.933
430	0	.00	98.9	1.1	4.408	3.024
440	0	.00	98.9	1.1	4.510	3.115
450	0	.00	98.9	1.1	4.613	3.205
460	0	.00	98.9	1.1	4.715	3.296
470	0	.00	98.9	1.1	4.818	3.387
480	0	.00	98.9	1.1	4.920	3.478
490	0	.00	98.9	1.1	5.023	3.569
500	0	.00	98.9	1.1	5.125	3.660
510	0	.00	98.9	1.1	5.228	3.751
520	0	.00	98.9	1.1	5.331	3.842
530	0	.00	98.9	1.1	5.433	3.933
540	1	1.15	100.0	.0	5.536	4.024

REMAINING FREQUENCIES ARE ALL ZERO

TABLE NUMBER 7 (TIME OVERRUN)

ENTRIES IN TABLE 13		MEAN ARGUMENT 32.231	STANDARD DEVIATION 26.606	NON-WEIGHTED		
UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
0	0	.00	.0	100.0	.000	-1.211
10	3	23.08	23.1	76.9	.310	-.836
20	2	15.38	38.5	61.5	.621	-.460
30	3	23.08	61.5	38.5	.931	-.084
40	1	7.69	69.2	30.8	1.241	.292
50	1	7.69	76.9	23.1	1.551	.668
60	1	7.69	84.6	15.4	1.862	1.044
70	1	7.69	92.3	7.7	2.172	1.420
80	0	.00	92.3	7.7	2.482	1.795
90	0	.00	92.3	7.7	2.792	2.171
100	0	.00	92.3	7.7	3.103	2.547
110	1	7.69	100.0	.0	3.413	2.923

REMAINING FREQUENCIES ARE ALL ZERO